

- 24 A container with rigid walls is covered with perfectly insulating material. The container is divided into two parts by a partition. One part contains a gas while the other is fully evacuated (vacuum). The partition is suddenly removed. The gas rushes to fill the entire volume and comes to equilibrium after a little time. If the gas is not ideal,
- the initial internal energy of the gas equals its final internal energy
  - the initial temperature of the gas equals its final temperature
  - the initial pressure of the gas equals its final pressure
  - the initial entropy of the gas equals its final entropy
- 25 Two bulbs of identical volumes connected by a small capillary are initially filled with an ideal gas at temperature  $T$ . Bulb 2 is heated to maintain a temperature  $2T$  while bulb 1 remains at temperature  $T$ . Assume throughout that the heat conduction by the capillary is negligible. Then the ratio of final mass of the gas in bulb 2 to the initial mass of the gas in the same bulb is close to
- $1/2$
  - $2/3$
  - $1/3$
  - $1$
- 26 Two rods, one made of copper and the other steel of the same length and cross sectional area are joined together. (The thermal conductivity of copper is  $385 \text{ J}\cdot\text{s}^{-1}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$  and steel is  $50 \text{ J}\cdot\text{s}^{-1}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$ .) If the copper end is held at  $100^\circ\text{C}$  and the steel end is held at  $0^\circ\text{C}$ , what is the junction temperature (assuming no other heat losses)?
- $12^\circ\text{C}$
  - $50^\circ\text{C}$
  - $73^\circ\text{C}$
  - $88^\circ\text{C}$

- 27 Jet aircrafts fly at altitudes above 30,000 ft where the air is very cold at  $-40^\circ\text{C}$  and the pressure is 0.28 atm. The cabin is maintained at 1 atm pressure by means of a compressor which exchanges air from outside adiabatically. In order to have a comfortable cabin temperature of  $25^\circ\text{C}$ , we will require in addition:
- a heater to warm the air injected into the cabin
  - an air-conditioner to cool the air injected into the cabin
  - neither a heater nor an air-conditioner: the compressor is sufficient
  - alternatively heating and cooling in the two halves of the compressor cycle
- 28 A speaker emits a sound wave of frequency  $f_0$ . When it moves towards a stationary observer with speed  $u$ , the observer measures a frequency  $f_1$ . If the speaker is stationary, and the observer moves towards it with speed  $u$ , the measured frequency is  $f_2$ . Then
- $f_1 = f_2 < f_0$
  - $f_1 > f_2$
  - $f_1 < f_2$
  - $f_1 = f_2 > f_0$
- 29 A plane polarized light passed through successive polarizers which are rotated by  $30^\circ$  with respect to each other in the clockwise direction. Neglecting absorption by the polarizers and given that the first polarizer's axis is parallel to the plane of polarization of the incident light, the intensity of light at the exit of the fifth polarizer is closest to
- same as that of the incident light
  - 17.5% of the incident light
  - 30% of the incident light
  - zero

- 30 At  $23^{\circ}\text{C}$ , a pipe open at both ends resonates at a frequency of 450 hertz. At what frequency does the same pipe resonate on a hot day when the speed of sound is 4 percent higher than it would be at  $23^{\circ}\text{C}$ ?

A. 446 Hz                      B. 454 Hz  
C. 468 Hz                      D. 459 Hz

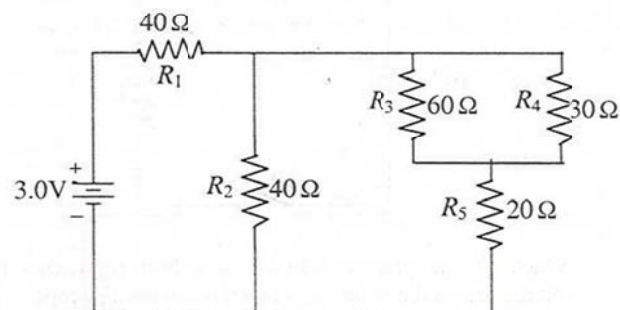
- 31 In a Young's double slit set-up, light from a laser source falls on a pair of very narrow slits separated by 1.0 micrometer and bright fringes separated by 1.0 millimeter are observed on a distant screen. If the frequency of the laser light is doubled, what will be the separation of the bright fringes?

A. 0.25 mm                    B. 0.5 mm  
C. 1.0 mm                      D. 2.0 mm

- 32 For a domestic AC supply of 220 V at 50 cycles per second, the potential difference between the terminals of a two-pin electric outlet in a room is given by

A.  $V(t) = 220\sqrt{2}\cos(100\pi t)$   
B.  $V(t) = 220\cos(50t)$   
C.  $V(t) = 220\cos(100\pi t)$   
D.  $V(t) = 220\sqrt{2}\cos(50t)$

- 33 In the circuit shown below the resistances are given in ohms and the battery is assumed ideal with emf equal to 3.0 volts. The resistor that dissipates the most power is

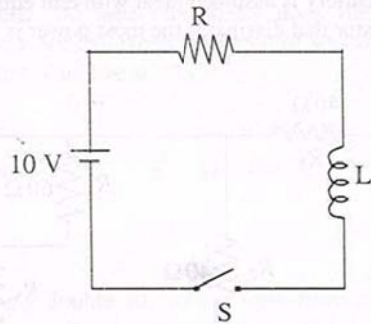


A.  $R_1$                               B.  $R_2$   
C.  $R_3$                               D.  $R_4$

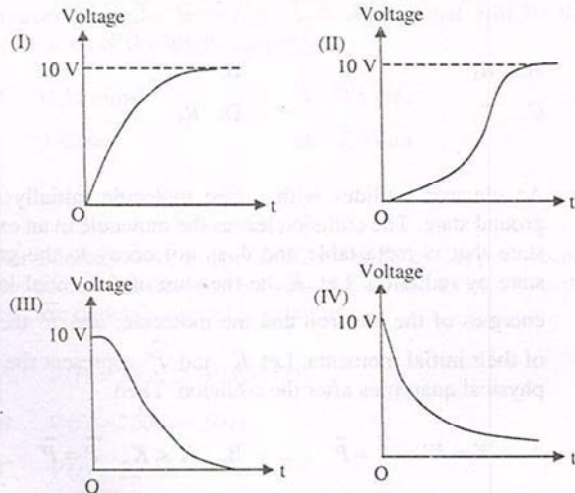
- 34 An electron collides with a free molecule initially in its ground state. The collision leaves the molecule in an excited state that is metastable and does not decay to the ground state by radiation. Let  $K$  be the sum of the initial kinetic energies of the electron and the molecule, and  $\vec{P}$  the sum of their initial momenta. Let  $K'$  and  $\vec{P}'$  represent the same physical quantities after the collision. Then

A.  $K = K'$ ,  $\vec{P} = \vec{P}'$               B.  $K' < K$ ,  $\vec{P} = \vec{P}'$   
C.  $K = K'$ ,  $\vec{P} \neq \vec{P}'$               D.  $K' < K$ ,  $\vec{P} \neq \vec{P}'$

- 35 In the circuit shown, the switch is closed at time  $t = 0$ .

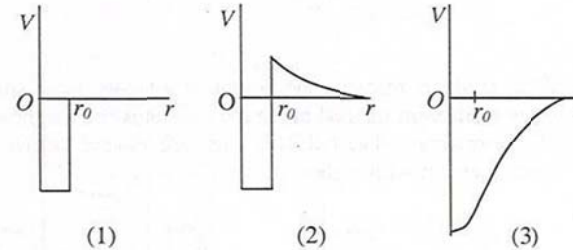


Which of the graphs shown below best represents the voltage across the inductor, as seen on an oscilloscope?



- A. I  
B. II  
C. III  
D. IV

- 36 Given below are three schematic graphs of potential energy  $V(r)$  versus distance  $r$  for three atomic particles: electron ( $e^-$ ), proton ( $p^+$ ) and neutron ( $n$ ), in the presence of a nucleus at the origin O. The radius of the nucleus is  $r_0$ . The scale on the  $V$ -axis may not be the same for all figures. The correct pairing of each graph with the corresponding atomic particle is



- A. (1,  $n$ ), (2,  $p^+$ ), (3,  $e^-$ )  
B. (1,  $p^+$ ), (2,  $e^-$ ), (3,  $n$ )  
C. (1,  $e^-$ ), (2,  $p^+$ ), (3,  $n$ )  
D. (1,  $p^+$ ), (2,  $n$ ), (3,  $e^-$ )

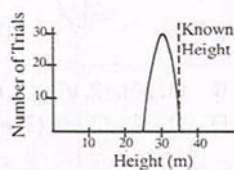
- 37 Due to transitions among its first three energy levels, hydrogenic atom emits radiation at three discrete wavelengths  $\lambda_1$ ,  $\lambda_2$ , and  $\lambda_3$  ( $\lambda_1 < \lambda_2 < \lambda_3$ ). Then
- A.  $\lambda_1 = \lambda_2 + \lambda_3$   
B.  $\lambda_1 + \lambda_2 = \lambda_3$   
C.  $1/\lambda_1 + 1/\lambda_2 = 1/\lambda_3$   
D.  $1/\lambda_1 = 1/\lambda_2 + 1/\lambda_3$
- 38 The total radiative power emitted by spherical blackbody with radius  $R$  and temperature  $T$  is  $P$ . If the radius is doubled and the temperature is halved then the radiative power will be

- A.  $P/4$   
B.  $P/2$   
C.  $2P$   
D.  $4P$

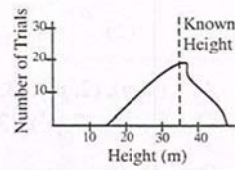
- 39 The Quantum Hall Resistance  $R_H$  is a fundamental constant with dimensions of resistance. If  $h$  is Planck's constant and  $e$  the electron charge, then the dimension of  $R_H$  is the same as

- A.  $e^2/h$                       B.  $h/e^2$   
 C.  $h^2/e$                         D.  $e/h^2$

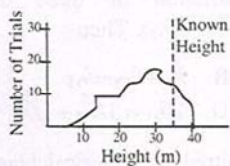
- 40 Four students measure the height of a tower. Each student uses a different method and each measures the height many different times. The data for each are plotted below. The measurement with highest precision is



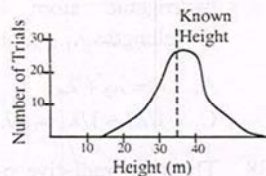
(I)



(II)



(III)



(IV)

- A. I                                      B. II  
 C. III                                    D. IV

## CHEMISTRY

- 41 The hybridizations of  $\text{Ni}(\text{CO})_4$  and  $\text{Cr}(\text{H}_2\text{O})_6^{2+}$ , respectively, are

- A.  $sp^3$  and  $d^3sp^2$                       B.  $dsp^2$  and  $d^2sp^3$   
 C.  $sp^3$  and  $d^2sp^3$                       D.  $dsp^2$  and  $sp^3d^2$

- 42 Extraction of silver is achieved by initial complexation of the ore (Argentite) with X followed by reduction with Y. X and Y, respectively, are

- A.  $\text{CN}^-$  and Zn                      B.  $\text{CN}^-$  and Cu  
 C.  $\text{Cl}^-$  and Zn                        D.  $\text{Br}^-$  and Zn

- 43 Assuming ideal behaviour, the enthalpy and volume of mixing of two liquids, respectively, are

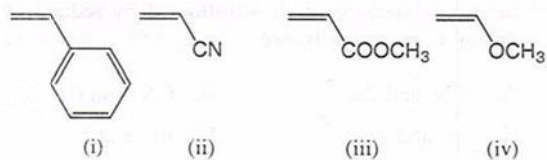
- A. zero and zero                      B. +ve and zero  
 C. -ve and zero                        D. -ve and -ve

- 44 At 298 K, the ratio of osmotic pressures of two solutions of a substance with concentrations of 0.01 M and 0.001 M, respectively, is

- A. 1                                        B. 100  
 C. 10                                        D. 1000

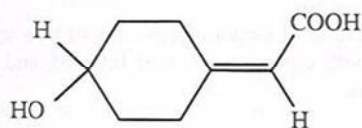
- 45 The rate of gas phase chemical reactions generally increases rapidly with rise in temperature. This is mainly because
- the collision frequency increases with temperature
  - the fraction of molecules having energy in excess of the activation energy increases with temperature
  - the activation energy decreases with temperature
  - the average kinetic energy of molecules increases with temperature

46 Among i-iv



the compound that does not undergo polymerization under radical initiation, is

- i
  - ii
  - iii
  - iv
- 47 Two possible stereoisomers for



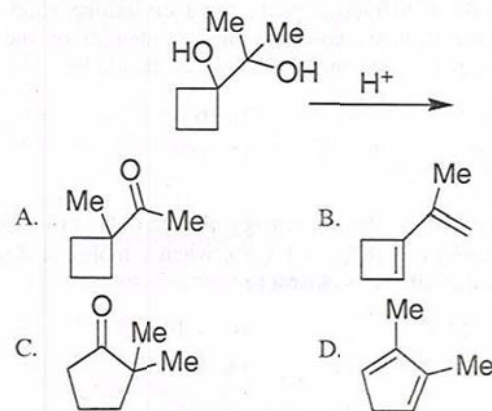
are

- enantiomers
- diastereomers
- conformers
- rotamers

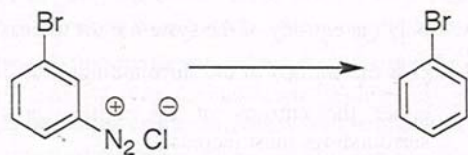
- 48 For a process to occur spontaneously
- only the entropy of the system must increase
  - only the entropy of the surroundings must increase
  - either the entropy of the system or that of the surroundings must increase
  - the total entropy of the system and the surroundings must increase

- 49 When the size of a spherical nanoparticle decreases from 30 nm to 10 nm, the ratio surface area/volume becomes
- 1/3 of the original
  - 3 times the original
  - 1/9 of the original
  - 9 times the original

50 The major product of the following reaction is :



- 51 For the transformation

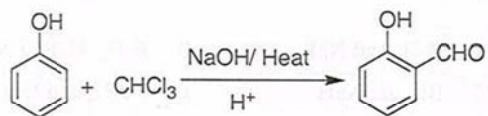


the reagent used is

- A.  $\text{LiAlH}_4$                       B.  $\text{H}_3\text{PO}_2$   
C.  $\text{H}_3\text{O}^+$                         D.  $\text{H}_2/\text{Pt}$
- 52 The values of the limiting molar conductivity ( $\Lambda^\circ$ ) for  $\text{NaCl}$ ,  $\text{HCl}$  and  $\text{NaOAc}$  are 126.4, 425.9 and  $91.0 \text{ S cm}^2 \text{ mol}^{-1}$ , respectively. For  $\text{HOAc}$ ,  $\Lambda^\circ$  in  $\text{S cm}^2 \text{ mol}^{-1}$  is
- A. 390.5                            B. 299.5  
C. 208.5                            D. 217.4
- 53 To obtain a diffraction peak, for a crystalline solid with interplane distance equal to the wavelength of incident X-ray radiation, the angle of incidence should be
- A.  $90^\circ$                             B.  $0^\circ$   
C.  $30^\circ$                             D.  $60^\circ$
- 54 The standard Gibbs free energy change ( $\Delta G^\circ$  in  $\text{kJ mol}^{-1}$ ), in a Daniel cell ( $E^\circ_{\text{cell}} = 1.1 \text{ V}$ ), when 2 moles of  $\text{Zn(s)}$  is oxidized at 298 K, is closest to
- A. -212.3                            B. -106.2  
C. -424.6                            D. -53.1

- 55 All the products formed in the oxidation of  $\text{NaBH}_4$  by  $\text{I}_2$ , are
- A.  $\text{B}_2\text{H}_6$  and  $\text{NaI}$               B.  $\text{B}_2\text{H}_6$ ,  $\text{H}_2$  and  $\text{NaI}$   
C.  $\text{BI}_3$  and  $\text{NaH}$                 D.  $\text{NaBI}_4$  and  $\text{HI}$
- 56 The spin-only magnetic moments of  $[\text{Mn}(\text{CN})_6]^{4-}$  and  $[\text{MnBr}_4]^{2-}$  in Bohr Magnetons, respectively, are
- A. 5.92 and 5.92                  B. 4.89 and 1.73  
C. 1.73 and 5.92                  D. 1.73 and 1.73
- 57 In a zero-order reaction, if the initial concentration of the reactant is doubled, the time required for half the reactant to be consumed
- A. increases two-fold              B. increases four-fold  
C. decreases by half                D. does not change
- 58 The adsorption isotherm for a gas is given by the relation  $x = ap/(1+bp)$  where  $x$  is moles of gas adsorbed per gram of the adsorbent,  $p$  is the pressure of the gas, and  $a$  and  $b$  are constants. Then  $x$
- A. increases with  $p$   
B. remains unchanged with  $p$   
C. decreases with  $p$   
D. increases with  $p$  at low pressures and then remains the same at high pressures

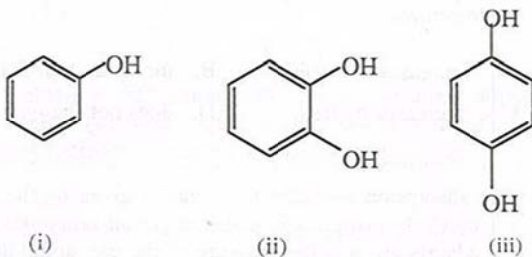
59 The reaction



is known as

- A. Perkin reaction
- B. Sandmeyer reaction
- C. Reimer-Tiemann reaction
- D. Cannizzaro reaction

60 Among i-iii



the boiling point follows the order

- A. ii < i < iii
- B. iii < ii < i
- C. i < ii < iii
- D. ii < iii < i

## BIOLOGY

61 The major constituents of neurofilaments are

- A. microtubules
- B. intermediate filaments
- C. actin filaments
- D. protofilaments

62 In which phase of the cell cycle are sister chromatids available as template for repair?

- A. G1 phase
- B. G2 phase
- C. S Phase
- D. M phase

63 A person has difficulty in breathing at higher altitudes because

- A. oxygen is likely to diffuse from lungs to blood.
- B. oxygen is likely to diffuse from blood to lungs.
- C. partial pressure of O<sub>2</sub> is lower than partial pressure of CO<sub>2</sub>.
- D. overall intake of O<sub>2</sub> by the blood becomes low.

64 In humans, the composition of a zygote that will develop into a female is

- A. 44A + XX
- B. 44A + XY
- C. 22 + X
- D. 23A

- 65 If you fractionate all the organelles from the cytoplasm of a plant cell, in which one of the following sets of fractions will you find nucleic acids?
- A. nucleus, mitochondria, chloroplast, cytoplasm
  - B. nucleus, mitochondria, chloroplast, glyoxysome
  - C. nucleus, chloroplast, cytoplasm and peroxisome
  - D. nucleus, mitochondria, chloroplast, Golgi bodies
- 66 A protein with 100 amino acid residues has been translated based on triplet genetic code. Had the genetic code been quadruplet, the gene that codes for the protein would have been:
- A. same in size
  - B. longer in size by 25%
  - C. longer in size by 100%
  - D. shorter in size
- 67 If the sequence of bases in DNA is 5'- ATGTATCTCAAT - 3', then the sequence of bases in its transcript will be:
- A. 5'- TACATAGAGTTA -3'
  - B. 5'- UACAUAGAGUUA -3'
  - C. 5'- AUGUAUCUCAAU -3'
  - D. 5'- AUUGAGAUACAU -3'
- 68 The  $\text{Na}^+/\text{K}^+$  pump is present in the plasma membrane of mammalian cells where it
- A. expels potassium from the cell.
  - B. expels sodium and potassium from the cell.
  - C. pumps sodium into the cell.
  - D. expels sodium from the cell.

- 69 The  $\text{CO}_2$  in the blood is mostly carried
- A. by haemoglobin in RBCs
  - B. in the cytoplasm of WBCs
  - C. in the plasma as bicarbonate ions
  - D. by plasma proteins
- 70 Patients who have undergone organ transplants are given anti-rejection medications to
- A. minimize infection
  - B. stimulate B-macrophage cell interaction
  - C. prevent T-lymphocyte proliferation
  - D. adopt the HLA of donor
- 71 Saline drip is given to a Cholera patient because
- A. NaCl kills *Vibrio cholera*
  - B. NaCl generates ATP
  - C.  $\text{Na}^+$  ions stops nerve impulse and hence sensation of pain
  - D.  $\text{Na}^+$  ions help in retention of water in body tissue
- 72 A water molecule can form a maximum of \_\_\_\_\_ hydrogen bonds.
- A. 1
  - B. 2
  - C. 3
  - D. 4